

Proposed bench-scale tests to investigate recovery from salt freeze-up events in trough fields

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Large-scale freeze up of salt within trough field will likely occur 1 or more times during the life of the plant

- Station blackout will lead to failure of salt circulation pumps and heat trace
 - Bare HCEs will likely exist in the field and will freeze first
 - Given freeze of one HCE, the entire loop will freeze
- Blackout frequency
 - Loss of offsite power (0.2 to 2 times/yr)
 - Emergency diesel failure probability (0.05 to 0.1)
 - Number of events is between 0.3 and 6 within 30 yr life
- We need to prove that thawing of the field is possible without damaging HCEs and other pipe
 - Financial investment community will require this



Bare Tube Heat Losses from SAND 94-1884 Test Results – SEGS LS-2 Solar Collector

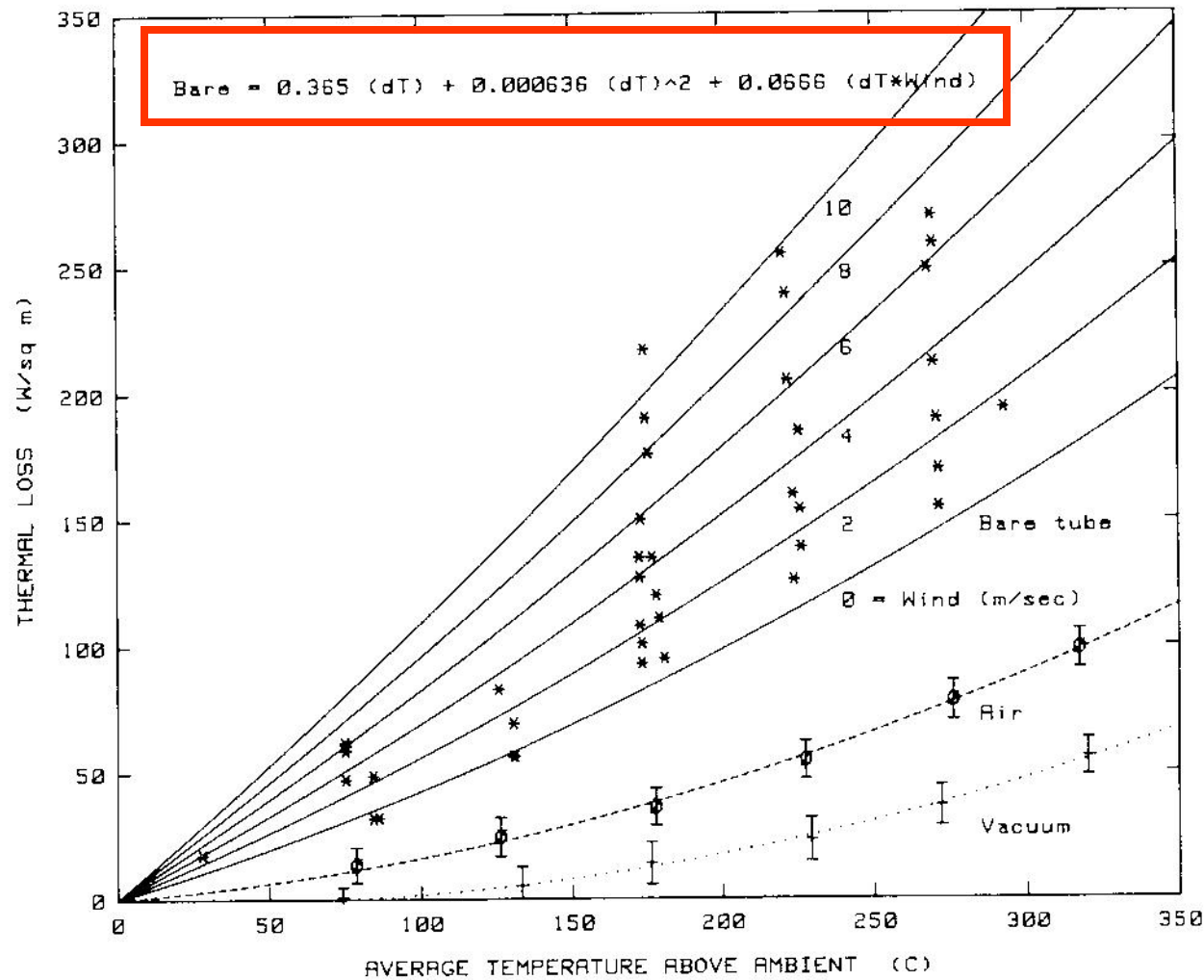
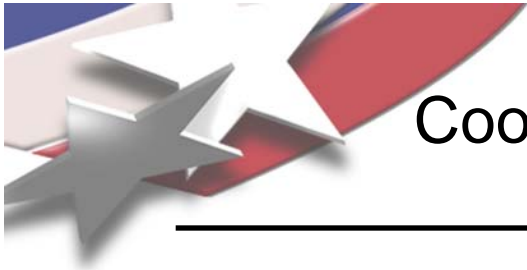
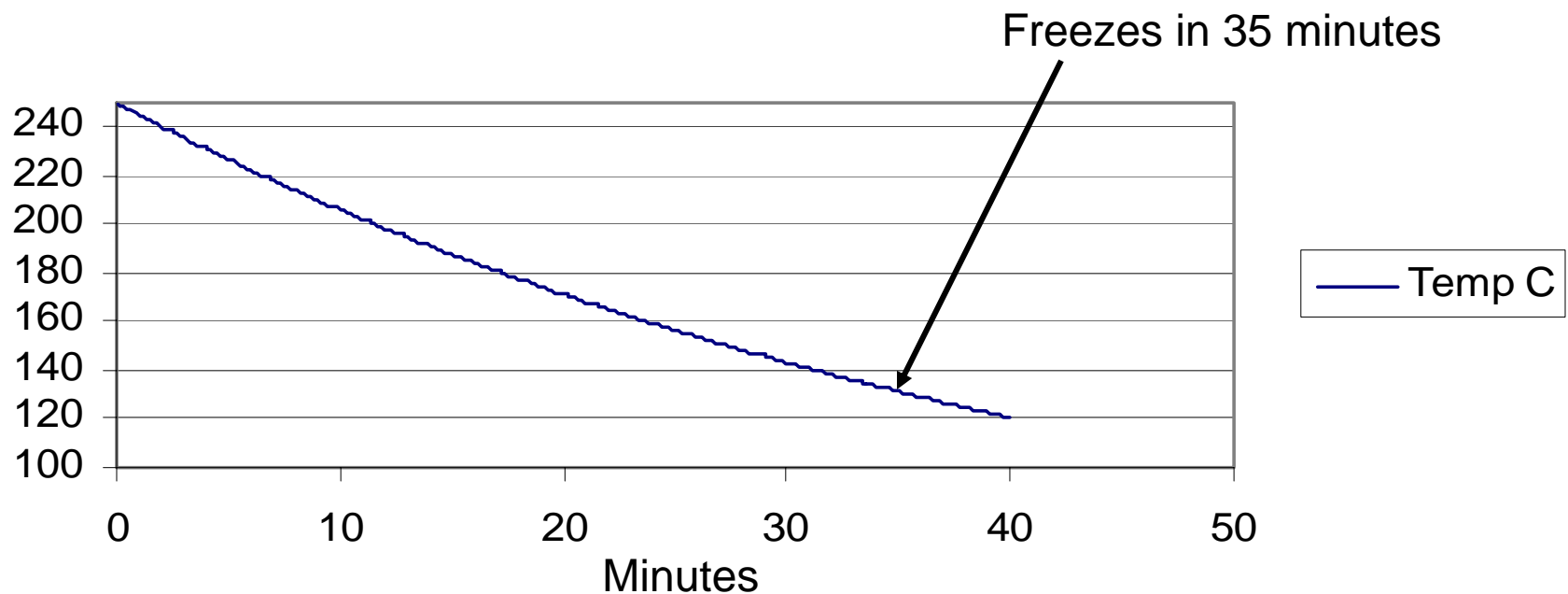


Figure D-15. SEGS LS-2 Thermal Loss vs. Temperature and Wind - Cermet Receiver.



Cooldown of HiTec XL in a stagnant, bare-tube HCE



Given 250 °C start, 10 °C ambient, 4 m/s wind (8.9 mph)



Salt freeze time in minutes

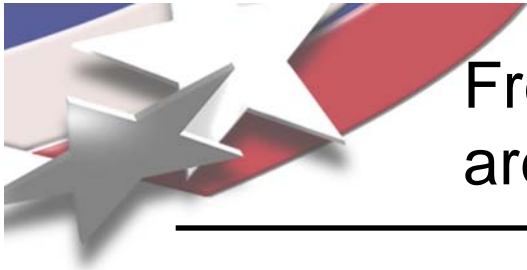
stagnant, bare-tube HCE
given $T_{amb} = 20\text{ }^{\circ}\text{C}$ (annual avg.)

Wind Speed

Start
Temperature

	0 mph	5 mph	10 mph	20 mph
150 °C	15	11	9	6
200 °C	41	31	25	18
250 °C	60	45	37	26
300 °C	74	56	46	33

Note: Average wind speed for Barstow is 11.7 mph



Freeze time can be extended if bare tubes are temporarily repaired with split-glass envelope

- Atmospheric-pressure air within annulus
- Wind does not significantly affect freeze time
- Calculation assumes $T_{amb} = 20\text{ }^{\circ}\text{C}$

Start Temp	Freeze Time (min)
150 °C	32
200 °C	88
250 °C	125
300 °C	150

- Recovery of offsite power becomes viable recovery action
- Probability of non-recovery in 40 minutes is ~0.25 (NUREG 1032)
- Number of freezes within 30 yr life reduced to between 0.08 and 1.5 events



Proposed HCE Thaw Test

- **Freeze HiTek and/or HiTek XL in one or more existing HCEs at Sandia**
- **Relatively easy test to perform (i.e. bench scale)**
- **Thaw HCE with impedance and/or internal heat trace methods**
- **Constrained flow vs. free flow of thawed salt**
- **Identify conditions that lead to damage**